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**UTILITY  
PATENT APPLICATION  
TRANSMITTAL**

(Only for new nonprovisional applications under 37 CFR 1.53(b))

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35.C14218

First Named Inventor or Application Identifier

MUNEKI ANDO ET AL.

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**APPLICATION ELEMENTS**

See MPEP chapter 600 concerning utility patent application contents.

**ADDRESS TO:**Assistant Commissioner for Patents  
Box Patent Application  
Washington, DC 202311. ☐ Fee Transmittal Form  
(Submit an original, and a duplicate for fee processing)2. ☒ Specification Total Pages **41**3. ☒ Drawing(s) (35 USC 113) Total Sheets **14**4. ☒ Oath or Declaration Total Pages **2**a. ☐ Newly executed (original or copy)b. ☒ Unexecuted for information purposesc. ☐ Copy from a prior application (37 CFR 1.63(d))  
(for continuation/divisional with Box 17 completed)  
[Note Box 5 below]i. ☐ **DELETION OF INVENTOR(S)**  
Signed Statement attached deleting inventor(s)  
named in the prior application, see 37 CFR  
1.63(d)(2) and 1.33(b).5. ☐ Incorporation By Reference (useable if Box 4c is checked)  
The entire disclosure of the prior application, from which a copy of the  
oath or declaration is supplied under Box 4c, is considered as being  
part of the disclosure of the accompanying application and is hereby  
incorporated by reference therein.6. ☐ Microfiche Computer Program (Appendix)7. Nucleotide and/or Amino Acid Sequence Submission  
(if applicable, all necessary)a. ☐ Computer Readable Copyb. ☐ Paper Copy (identical to computer copy)c. ☐ Statement verifying identity of above copies**ACCOMPANYING APPLICATION PARTS**8. ☐ Assignment Papers (cover sheet & document(s))9. ☐ 37 CFR 3.73(b) Statement ☐ Power of Attorney  
(when there is an assignee)10. ☐ English Translation Document (if applicable)11. ☐ Information Disclosure Statement (IDS)/PTO-1449 ☐ Copies of IDS  
Citations12. ☐ Preliminary Amendment13. ☒ Return Receipt Postcard (MPEP 503)  
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Status still proper and desired15. ☐ Certified Copy of Priority Document(s)  
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17. If a CONTINUING APPLICATION, check appropriate box and supply the requisite information:

☐ Continuation ☐ Divisional ☐ Continuation-in-part (CIP) of prior application No. \_\_\_\_/\_\_\_\_**18. CORRESPONDENCE ADDRESS**☒ Customer Number or Bar Code Label

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CLAIMS	(1) FOR	(2) NUMBER FILED	(3) NUMBER EXTRA	(4) RATE	(5) CALCULATIONS
	TOTAL CLAIMS (37 CFR 1.16(c))	79-20 =	59	X \$ 18.00 =	\$1062.00
	INDEPENDENT CLAIMS (37 CFR 1.16(b))	6-3 =	3	X \$ 78.00 =	\$234.00
	MULTIPLE DEPENDENT CLAIMS (if applicable) (37 CFR 1.16(d))			\$260.00 =	\$260.00
				BASIC FEE (37 CFR 1.16(a))	\$690.00
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	TOTAL =				\$2246.00

19. Small entity status

- a. ☐ A Small entity statement is enclosed
- b. ☐ A small entity statement was filed in the prior nonprovisional application and such status is still proper and desired.
- c. ☐ Is no longer claimed.

20. ☒ A check in the amount of \$ 2246.00 to cover the filing fee is enclosed.

21. ☐ A check in the amount of \$ \_\_\_\_\_ to cover the recordal fee is enclosed.

22. The Commissioner is hereby authorized to credit overpayments or charge the following fees to Deposit Account No. 06-1205:

- a. ☒ Fees required under 37 CFR 1.16.
- b. ☒ Fees required under 37 CFR 1.17.
- c. ☐ Fees required under 37 CFR 1.18.

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED	
NAME	Jack M. Arnold
SIGNATURE	<i>Jack M. Arnold Reg. No. 25,823</i>
DATE	January 14, 2000

## IMAGE DISPLAY APPARATUS AND METHOD

### BACKGROUND OF THE INVENTION

#### Field of the Invention

5           The present invention relates to an image display apparatus and to a method for employing a display device to display an image. In particular, the present invention pertains to an arrangement for forming an image on a plane.

#### 10   Related Background Art

          Fig. 15 is a diagram illustrating a conventional image display apparatus that displays an image by employing pulse width modulation for which all start times for driving modulation signals are identical.

15   Fig. 16 is a timing chart showing the operational timing for the image display apparatus. In Fig. 15, the image display apparatus comprises: a timing controller 1, for generating the operational timing for the apparatus; an A/D converter 2, for converting an

20   image signal S1 into a digital signal S2 representing the luminance of each pixel; a display panel 4, across which display devices are distributed, one at each intersection of lines arranged as columns and rows; a column selection controller 3, for controlling the

25   selection of the lines arranged as columns on the display panel 4; a shift register 5, for distributing the digital image signal S2; PWM generators 6, for

performing pulse width modulation for a luminance  
signal received by the shift register 5 and for  
controlling the display luminance; and a row driver 7,  
which includes the shift register 5 and the PWM  
5 generators 6.

With this arrangement, an input image signal S1 is  
converted by the A/D converter 2 into a digital signal  
S2 representing the luminance of each pixel, and the  
digital signal is transmitted to the PWM generator 6  
10 for a pixel. Each of the PWM generators 6 employs a  
signal from the timing controller 1 to modulate the  
luminance signal to obtain a pulse length, and drives a  
line arranged as a row on the display panel 4. At the  
same time, the column selection controller 3  
15 sequentially drives a column corresponding to a pixel  
that is to be displayed. Individual devices can  
therefore be driven in accordance with the image  
signals.

The structure of a PWM generator 6 is shown in  
20 Fig. 17, and the operational timing is shown in Fig.  
19. In Fig. 17, a clock generator 10 supplies a clock  
pulse S10. Upon the arrival of the clock pulse at a  
terminal CK, a down counter 11 decrements by one the  
value held by an internal register ct (not shown).  
25 When the counter value reaches 0, the counting by the  
down counter 11 is halted and a terminal NZ is set  
high. Then, when a pulse is input at a terminal LOAD,

the down counter 11 loads an input value DATA into the internal register, and resumes the counting. And an output driver 12 receives the level set for the terminal NZ of the down counter 11 and drives the display panel 4.

A signal S11 received at the terminal LOAD of the down counter 1 is a timing signal for loading the luminance signal S12, and is either a horizontal synchronization signal or another signal based on it.

The luminance signal S12 input at the terminal DATA is a digital luminance signal; a signal S13 (Fig. 19) is a value held in the register ct of the down counter 11; a signal S14 goes high when the internal register value S13 is other than 0; and a signal S15 emitted by the output driver 12 is a modulation signal output in accordance with the signal S14.

In Fig. 15, the thus arranged PWM generator 6 performs the above operation to modulate into a pulse length the luminance signal received from the shift register 5, and outputs the resultant signal to the display panel 4.

In the arrangement in Fig. 15, for example, a floating capacitance called an inter-line capacitance is present between the individual lines of the display panel 4. If a drive signal having a waveform shown in Fig. 20 is to be transmitted to the n-th line, for example, the signal for the n-th line is affected by

the trailing edges of drive signals that are transmitted to the adjacent (n-1)th and (n+1)th lines, and its waveform is distorted as is shown in Fig. 21. This occurs because of crosstalk induced by inter-line capacitance.

#### SUMMARY OF THE INVENTION

To resolve the above shortcomings, it is one objective of the present invention to provide an image display apparatus whereby a satisfactory image can be displayed, and an image display method whereby display of a satisfactory image can be ensured.

To achieve the above objective, according to a first aspect of the present invention, an image display apparatus comprises:

a plurality of lines;

a plurality of display devices to which signals are respectively applied by the plurality of lines; and

a signal circuit for generating the signals, each of which has a duration equivalent to a high-level period corrected in accordance with the length of a high-level period for a signal that is to be applied to a line adjacent to each of the plurality of lines.

The signal circuit includes a modulation circuit for generating a signal having a duration equivalent to a high-level period that is consonant with a signal having a predetermined value. The signal having a

duration equivalent to the corrected high-level period  
may be a signal that is generated, by the modulation  
circuit, in accordance with another signal having a  
value that is corrected based on the value of a  
5 luminance signal corresponding to the signal to be  
applied to an adjacent line.

Since the length of the high-level period of the  
signal to be applied to an adjacent line can be  
ascertained from the value of the luminance signal that  
10 corresponds to the signal to be applied to the adjacent  
line, the value of the signal to be input to the  
modulation circuit can be corrected by using the length  
of the high-level period. As a result, based on the  
corrected signal, a signal having a duration equivalent  
15 to the high-level period can be produced by the  
modulation circuit.

The signal circuit includes a modulation circuit  
for generating a signal having a duration equivalent to  
a high-level period that is consonant with a signal  
20 having a predetermined value. And the signal having a  
duration equivalent to the corrected high-level period  
may be a signal that is generated, by the modulation  
circuit, in accordance with a signal having a value  
that is corrected based on the length of the high-level  
25 period of the signal to be applied to an adjacent line.

For the correction, based on the length of the  
high-level period, of the signal to be output to an

adjacent line, the length of the high-level period need not be directly detected. Specifically, when a signal to be output to a line adjacent to a specific line is detected, and especially when a change in the level of the signal is detected, the degree to which that change affects the level of the signal to be output to the pertinent line can be predicted. Thus, the length of the high-level period of a signal to be output to the pertinent line can be corrected.

During a predetermined time period, the signal circuit may transmit, to the plurality of lines, signals for which the rising times in high-level periods are identical. For each of the signals to be applied to the lines, the signal circuit may extend the length of the high-level period when the length of the high-level period for a signal to be applied to an adjacent line is shorter.

During a predetermined time period, the signal circuit may transmit, to the plurality of lines, signals for which the falling times in high-level periods are identical. For each of the signals to be applied to the lines, the signal circuit may reduce the length of the high-level period when the length of the high-level period for a signal to be applied to an adjacent line is shorter.

According to a second aspect of the present invention, an image display apparatus comprises:



a plurality of lines;

a plurality of display devices to which signals are respectively applied by the plurality of lines; and

5 a signal circuit for generating the signals, each of which has a duration equivalent to a high-level period corrected in accordance with the number of times the level of a signal, which is to be applied to an adjacent line, is changed during a high-level period for a signal that is to be applied to each of the  
10 plurality of lines.

To correct the length of a high-level period in accordance with the number of times the level of the signal to be applied to an adjacent line is changed, only the number of occurrences of a level change that  
15 affects the level of a signal to be applied to a pertinent line need be considered.

The signal circuit includes a modulation circuit for producing a signal having a duration equivalent to a high-level period that is consonant with a signal  
20 having a predetermined value. The corrected signal, which has a duration equivalent to a high-level period, may be produced by the modulation circuit in accordance with a signal having a value that is corrected based on the value of a luminance signal that corresponds to a  
25 signal to be applied to an adjacent line.

The value of the luminance signal that corresponds to the signal to be applied to a line adjacent to a

specific line is employed in order to obtain the number of times the level of a signal, which is to be applied to an adjacent line, is changed during the high-level period for a signal to be applied to the specific line.

5 Therefore, the value of a signal input to the modulation circuit can be corrected based on the number of occurrences, and the modulation circuit can produce a signal that has a duration equivalent to the high-level period that is based on the corrected signal.

10 The signal circuit includes a modulation circuit for producing a signal having a duration equivalent to a high-level period that is consonant with a signal having a predetermined value. The corrected signal having a duration equivalent to a high-level period may  
15 be a signal having a duration equivalent to a high-level period that is corrected based on the number of times the level of a signal that is to be applied to the adjacent line is changed. Upon the detection of a level change for a signal to be applied to a line  
20 adjacent to a specific line, which occurs during a high-level period for a signal to be applied to the specific line, the duration of the high-level period of the signal to be applied to the specific line can be corrected.

25 During a predetermined period of time, the signal circuit may transmit, to the plurality of lines, signals for which the rising times in a high-level

period are identical. When a signal to be applied to an adjacent line in the high-level period falls, the signal circuit may extend the length of the high-level periods for the signals to be applied to the plurality of lines.

During a predetermined period of time, the signal circuit may transmit, to the plurality of lines, signals for which the falling times in a high-level period are identical. When a signal to be applied to an adjacent line in the high-level period rises, the signal circuit may reduce the length of the high-level periods for the signals to be applied to the plurality of lines.

According to a third aspect of the present invention, an image display apparatus comprises:

a plurality of lines;

a plurality of display devices to which signals are respectively applied by the plurality of lines; and

a signal circuit for generating the signals, each of which, when output to one of the plurality of lines, has a duration that is equivalent to a high-level period that is corrected in order to reduce a change in luminance that occurs in response to a level change for a signal that is to be applied to an adjacent line.

The signal circuit may output a signal, which has a duration that is equivalent to a high-level period that is corrected in order to reduce a change in

luminance that occurs in response to a level change,  
for a signal to be applied to an adjacent line, that  
occurs during the high-level period for each of the  
signals that are to be applied to each of the plurality  
5 of lines.

For each of the above described aspects, it is  
preferable that a second line be provided along which a  
signal can be applied to simultaneously set the  
plurality of display devices to a semi-driven state.

10 The semi-driven state represents a state in which, in  
actuality, the display devices are not driven, but in  
which they can be driven when a signal from the signal  
circuit goes high. Thus, when a signal from the signal  
circuit does not go to a predetermined high level, even  
15 though a signal for setting a semi-driven state has  
been transmitted, and when a signal for setting a semi-  
driven state is not transmitted, even though a signal  
from the signal circuit has reached a predetermined  
high level, the display devices are not actually  
20 driven.

It is preferable that a plurality of the second  
lines be provided and that the plurality of display  
devices correspond respectively to the second lines.  
Additionally, it is preferable that a plurality of  
25 lines along which a signal from the signal circuit is  
transmitted be arranged substantially perpendicular to  
the second lines. And further, it is preferable that a

plurality of display devices be respectively located at a plurality of intersections at which the second lines and the lines along which signals are transmitted by the signal circuit intersect each other.

5           In addition, it is preferable that the signal for setting the semi-driven state be a scan signal for sequentially selecting the second lines.

10           Furthermore, it is preferable that the display devices be composed of electron emission devices, and that, in order to form an image, phosphors be irradiated by electron beams that are emitted by the electron emission devices. For this purpose, an electron emission device can be a surface conductive electron emission device, an FE electron emission  
15           device, or an MIM electron emission device. When the strength of an electron beam emitted by an electron emission device and projected onto a phosphor for a predetermined period of time is controlled by using a signal received from the signal circuit, a desirable  
20           luminance value can be obtained.

          It should be noted that the present invention also includes an arrangement for performing another correction in addition to the correction preformed for the high-level period. The high level of a signal  
25           represents a signal level that corresponds to a desirably high driven state, so that in essence an image is formed relative to a signal level

corresponding to a state wherein the display device is substantially not driven, or a state wherein the display device is in effect driven low and does not function effectively. The high level of a signal does not simply represent a high potential state of a signal relative to a low potential state.

According to a fourth aspect of the present invention, provided is an image display method, for displaying an image using a plurality of lines and a plurality of display devices to which signals are respectively applied by the plurality of lines, whereby the display devices are driven by the output, to the plurality of lines, of a signal that has a duration, which is equivalent to a high-level period, that is corrected in accordance with the length of a high-level period for a signal that is to be applied to a line adjacent to each of the plurality of lines.

According to a fifth aspect of the present invention, provided is an image display method, for displaying an image using a plurality of lines and a plurality of display devices to which signals are respectively applied by the plurality of lines, whereby the display devices are driven by the output, to the plurality of lines, of a signal having a duration, which is equivalent to a high-level period, that is corrected in accordance with the number of times the level of a signal that is to be applied to an adjacent

line is changed during a high-level period for a signal that is to be applied to each of the plurality of lines.

According to a sixth aspect of the present invention, provided is an image display method, for displaying an image using a plurality of lines and a plurality of display devices to which signals are respectively applied by the plurality of lines, whereby the display devices are driven by the output, to the plurality of lines, of a signal that has a duration, which is equivalent to a high-level period, that is corrected in order to reduce a change in luminance, which is due to a change in the level of a signal that is to be applied to an adjacent line.

When, as the result of a correction that was made for the high-level period, the length of a signal to be applied to the plurality of lines is changed and a further correction is required, for example, when as the result of the correction that was made for the high-level period the signal is affected under the influence of an adjacent line, an influence which conventionally need not be taken into consideration, the same steps are repeated as are required to perform the original correction.

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#### BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram illustrating the

arrangement of an image display apparatus according to a first embodiment of the present invention;

Fig. 2 is a block diagram illustrating the arrangement of a PWM generator in the apparatus in Fig. 1;

Fig. 3 is a diagram showing the shifting of the operating state of the PWM generator in Fig. 2;

Fig. 4 is a timing chart for the operation of the PWM generator in Fig. 2;

Fig. 5 is a block diagram illustrating the arrangement of an image display apparatus according to a second embodiment of the present invention;

Fig. 6 is a block diagram showing the arrangement of a PWM generator in the apparatus in Fig. 5;

Fig. 7 is a diagram showing the shifting of the operating state of the PWM generator in Fig. 6;

Fig. 8 is a timing chart showing the operation of the PWM generator in Fig. 6;

Fig. 9 is a block diagram illustrating the arrangement of a PWM generator according to a third embodiment of the present invention;

Fig. 10 is a diagram showing the shifting of the operating state of the PWM generator in Fig. 9;

Fig. 11 is a timing chart showing the operation of the PWM generator in Fig. 9;

Fig. 12 is a waveform diagram showing waveforms modulated by the PWM generator in Fig. 9;



Fig. 13 is a waveform diagram showing the state wherein the waveform in Fig. 12 fluctuates in a direction in which the effective value of a pulse is increased;

5        Fig. 14 is a waveform diagram showing the state wherein the waveform in Fig. 13 is corrected;

Fig. 15 is a block diagram showing the arrangement of a conventional image display apparatus that uses pulse width modulation to drive a matrix display panel.

10       Fig. 16 is a timing chart for the operation of the display device in Fig. 15;

Fig. 17 is a block diagram illustrating the arrangement of a PWM generator in the apparatus in Fig. 15;

15       Fig. 18 is a diagram showing the shifting of the operating state of the PWM generator of the apparatus in Fig. 15;

Fig. 19 is a timing chart for the operation of the PWM generator of the apparatus in Fig. 15;

20       Fig. 20 is a waveform diagram showing the drive waveforms for three adjacent lines in the apparatus in Fig. 15;

Fig. 21 is a waveform diagram showing example fluctuation of the waveform in Fig. 20 due to drive waveform crosstalk along adjacent lines; and

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Fig. 22 is a waveform diagram showing a drive waveform in which a compensation pulse is inserted to

correct the fluctuation of the waveform caused by the crosstalk in Fig. 21.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

5           According to the preferred embodiments of the present invention, correction means is addition means for adding together a luminance signal and a correction signal or a pulse delay means for employing a correction signal to extend a period for applying the pulse of a modulation signal, and conversion means is 10 an analog-digital converter. Also, in order to display an image, while a line arranged as a column is selected, drive means transmits a drive signal to a line arranged as a row, and correction signal generation means generates a correction signal for each 15 like arranged line based on a luminance signal or a modulation signal for a like arranged adjacent line.

          The modulation means employs pulse width modulation (PWM) as a modulation method, and when the 20 modulation method employed by the modulation means is pulse width modulation, whereby an identical start time is used for driving a modulation signal for each line arranged as a row, the correction signal generation means either generates a correction signal, with which 25 the strength of a luminance signal for each line arranged as a row is increased when it is stronger than a luminance signal for a like arranged adjacent line,

or generates a correction signal, with which a luminance signal for each line arranged as a row is extended when it is longer than the pulse of a modulation signal for a like arranged adjacent line.

5 When the modulation method employed by the modulation means is pulse width modulation, in accordance with an end time, for the driving of a modulation signal, that is identical for each line arranged as a row, the correction signal generation means generates a  
10 correction signal, with which the strength of a luminance signal for a line arranged as a row is reduced when it is stronger than a luminance signal for a like arranged adjacent line. The drive means uses a constant current to drive the display devices, and in  
15 this case, since the fluctuation of a modulation signal due to crosstalk is especially remarkable, the present invention is effective. The display devices, which are electron emission devices that form images by irradiating phosphors with the electron beams that they  
20 emit, can be surface conductive electron emission devices, FE electron emission devices, or MIM electron emission devices.

The preferred embodiments of the present invention will now be described while referring to the  
25 accompanying drawings.

[First Embodiment]

Fig. 1 is a diagram showing the arrangement of an

image display apparatus according to a first embodiment of the present invention. The operational timing is the same as that shown in Fig. 16. In Fig. 1, the image display apparatus comprises: a timing controller 1, for generating the operational timing for the apparatus; an A/D converter 2, for converting an input image signal S1 into a digital signal S2 that represents the luminance for each pixel; a column selection controller 3, for controlling a column selection line for a display panel 4; the display panel 4, whereon lines are arranged as columns and rows, and whereon, at intersections of such lines, display devices are disposed; a shift register 5, for distributing the digital luminance signals S2; PWM generators 26, for performing pulse width modulation for the luminance signals transmitted by the shift register 5, and for controlling the display luminance; and a row selection controller 7, which includes the shift register 5 and the PWM generators 26.

With this arrangement, the input image signal S1 is converted by the A/D converter into a digital signal that represents the luminance of each pixel, and the digital signal is transmitted by the shift register 5 to the PWM generators 26 corresponding to the individual pixels. Each of the PWM generators 26 receives not only a luminance signal for its own line, but also a luminance signal for adjacent lines. The

PWM generator 26 employs the signal from the timing controller 1 to modulate the luminance signal for its own line into a pulse length, and drives the line arranged as a row on the display panel 4. At the same time, the column selection controller 3 sequentially drives lines arranged as columns that correspond to pixels to be displayed. As a result, the devices on the display panel 4 are driven in accordance with the image signal.

10       The arrangement of the PWM generator 26 is shown in Fig. 2, the shifting of the operating state is shown in Fig. 3, and the operational timing is shown in Fig. 4. In Fig. 2, a clock generator 10 supplies a clock pulse signal S10 to a down counter 11. Upon receiving  
15       the clock pulse signal S10 at the terminal CK, the down counter 11 decrements by one the value held by an internal register ct (not shown). When the counter value reaches 0, the down counter 11 halts the counting and sets the terminal NZ to a high level. When the  
20       pulse of a signal S11 is input to the terminal LOAD, the down counter 11 loads the value of DATA input to the internal register and resumes the counting. An output driver 12 receives the level of the terminal NZ of the down counter 11, and drives the display panel 4  
25       (see Fig. 1). A crosstalk correction unit 13 receives, at terminals dp and dn, luminance signals S18 and S19 for adjacent lines, and employs these signals to

correct for its own line a luminance signal S17 that is input at terminal d.

5 The signal S11 is a timing signal for loading the luminance signal S12, and either is a horizontal synchronizing signal, or a signal based on that signal. The signal S12 is a digital luminance signal. The signal S13 in Fig. 4 is the value held by the register of the down counter 11. The signal S14 output at the terminal NZ of the down counter 11 is a signal that goes high when the value S13 of the internal register is other than 0. The signal S15 of the output driver 12 is a modulation signal output in accordance with the signal S14. The crosstalk correction unit 13 uses the signal S17, which is a luminance signal that is input at the terminal d, for its own line for which pulse width modulation is to be performed.

20 The waveform fluctuates due to crosstalk when the signal for an adjacent line goes low earlier than does the line of the crosstalk correction unit 13. Thus, when the luminance signals S18 and S19 for the adjacent lines are lower than the luminance signal S17, the crosstalk correction unit 13 raises the luminance signal for its own line, and extends the pulse length to perform corrections equally. Specifically, suppose 25 that the values of the signals S17, S18 and S19 are  $d_p$ ,  $d$  and  $d_n$ . As is shown in Fig. 3, by using the addition means,  $d = d + 1$  is established when  $d > d_p$ , and also

when  $d > d_n$ , so that the luminance signal is raised by one tone. When  $d > d_p$  and  $d > d_n$ ,  $d = d + 2$  is established, and is employed as an initial value to be loaded to the down counter 11, so that the luminance signal is raised by two tones.

With the above described arrangement and operation, the PWM generators 26 can output a pulse obtained by correcting the fluctuation of the waveform that is caused by crosstalk at the adjacent lines.

In this embodiment, an explanation has been given for a case wherein the pulse width, which is equivalent to the fluctuation of the waveform that occurs when one adjacent line goes low first, is equivalent to one tone. However, even in a case where the equivalent pulse width is another value, such as a value equivalent to two tones, the fluctuation of the waveform can also be corrected by establishing  $d = d + 2$  when  $d > d_p$ . In addition, the internal register  $ct$  of the down counter 11 must have a satisfactory number of digits to prevent the occurrence of an overflow, even when a signal  $d$  is received after a correction has been made.

Since the luminance signal is corrected based on a correction signal, a compensation pulse shown in Fig. 22, for example, is added that can limit the degree to which the modulation signal is affected by crosstalk. With the added compensation pulse, equal corrections

can be provided for the waveform fluctuations attributable to the effect of other lines. Therefore, the display devices are driven by precise pulse width modulation and the affect of the crosstalk that is produced by waveforms on adjacent lines is reduced.

If the values of d relative to three adjacent lines A, B and C are, for example, 99, 100 and 100, the signal transmitted to line B is affected when the signal transmitted to line A rises first, so that under the above described correction control a value of 101 is loaded into the down counter 11. However, the signal transmitted to line C accordingly falls earlier than the signal transmitted to line B. To reduce the effect of such a fall, therefore, the same correction must be performed, based on the signal value obtained after the previous correction, and the initial values for lines A, B and C that are to be loaded into the down counter must be set to 99, 102 and 100.

[Second Embodiment]

Fig. 5 is a diagram illustrating the arrangement of an image display apparatus according to a second embodiment of the present invention. In this apparatus, the method for correcting a luminance signal and the structure of a PWM generator in the first embodiment are changed. That is, in Fig. 5, each of the PWM generators 36 receives not only a luminance signal for its own line, but also receives signals from



the PWM generators 36 on adjacent lines. Other arrangements are the same as those for the first embodiment.

The structure of a PWM generator 36 is shown in Fig. 6, the shifting of the operating state is shown in Fig. 7, and the operational timing is shown in Fig. 8. In Fig. 6, a down counter 21 is substantially the same as the down counter 11 in Fig. 2, except for the addition of terminals NZP and NZN. The signals output by PWM generators 36 on adjacent lines are input at the terminals NZP and NZN. Although to simplify the drawing in Fig. 5, in the illustration it is indicated that the output signals are fetched directly from the lines, in actuality, a PWM signal S14 output by the down counter 21 is supplied to the terminals NZP and NZN of adjacent PWM generators 36. The remainder of the structure is the same as that shown for the PWM generator in Fig. 2.

With this structure, the down counter 21, which also serves as pulse delay means, decrements the count value, and when the value held by the internal register reaches 0, the down counter 21 examines the states of the terminals NZP and NZN. When the level at either terminal NZP or NZN is low, the down counter 21 outputs a pulse equivalent to one clock, and when the levels at both of the terminals NZP and NZN are low, the down counter 21 outputs a pulse equivalent to two clocks.

In this manner, the pulse width is extended and the fluctuation of a waveform is corrected. The remaining structures and operations are the same as those for the first embodiment.

5 [Third Embodiment]

In the first embodiment, a PWM generator is employed that outputs modulation waveforms for which the start times for the driving of a modulation signal are identical. In this embodiment, a PWM generator is employed that outputs modulation waveforms, shown in Fig. 12, for which the end times for driving a modulation signal are identical. In this case, the fluctuation of a waveform can be corrected by using an arrangement that is substantially the same. Since, as is shown in Fig. 13, the waveform fluctuates in a direction in which the effective value of a pulse is increased, the PWM generator in this embodiment corrects the fluctuation to reduce the PWM pulse, as is shown in Fig. 14. The overall arrangement of the image display apparatus is the same as that of the first embodiment.

The structure of a PWM generator used for this embodiment is shown in Fig. 9, the shifting of the operating state is shown in Fig. 10, and the operational timing is shown in Fig. 11. In Fig. 9, a comparator 14 outputs to the terminal OUT a value of 1 when  $(IN+) \geq (IN-)$  and a value of 0 when  $(IN+) < (IN-)$ ,

and also, as a special state, constantly outputs a value of 0 when  $(IN-) = 0$ . A down counter 31 substitutes 255 into the internal counter  $ct$  when the input LOAD goes high, and, based on a clock input CK, decrements the count value until the value held by the internal counter  $ct$  reaches 0, at which time the counting is halted. To facilitate this the value S22 held by the counter  $ct$  is constantly transmitted to the terminal IN- of the comparator 14. Concurrently, a crosstalk correction unit 33 receives luminance signal S17 for its own line and luminance signals S18 and S19 for adjacent lines, and when the values of the respective luminance signals are  $dp$ ,  $d$  and  $dn$ ,  $DATA = d$  is output to the terminal DATA if  $d \leq dp$  and  $d \leq dn$ ,  $DATA = d - 2$  is output if  $d > dp$  and  $d > dn$ , and  $DATA = d - 1$  is output in all other cases.

When the horizontal synchronizing signal S11 is received by the counter 31, the value 255 held by the internal counter  $ct$  is decremented. Meanwhile, the comparator 14 compares the output S12 of the crosstalk correction unit 33 with the output S22 of the down counter 31 to obtain the PWM output S14 shown in Fig. 14.

Other arrangements and operations are the same as those in the first embodiment.

In the first to the third embodiments, only the affect of the adjacent lines is taken into

consideration. However, if needed, not only the affect of the adjacent lines, but also the affect of the level change of a signal to be transmitted to other lines, such as lines that are adjacent to the aforementioned adjacent lines, may be taken into account.

Further, in the above embodiments, since a correction signal is generated for each line arranged as a row and is employed to correct a luminance signal or a modulation signal, equal corrections can be provided for the fluctuations of drive waveforms that are caused by interference between parallel lines that are arranged as rows.

The arrangements for which the present invention can be applied are not limited to those mentioned in the descriptions of the first to the third embodiments. The present invention can be preferably employed for any arrangement wherein a signal level is substantially affected by a level change for a signal that is transmitted by an adjacent line.

As is described above, according to the present invention, the affect of the fluctuation of a signal that is caused by interference between the lines of an image display apparatus can be reduced.

WHAT IS CLAIMED IS:

1. An image display apparatus comprising:  
a plurality of lines;  
a plurality of display devices to which signals  
5 are respectively applied by said plurality of lines;  
and

a signal circuit for generating said signals, each  
of which has a duration equivalent to a high-level  
period corrected in accordance with the length of a  
10 high-level period for a signal that is to be applied to  
a line adjacent to each of said plurality of lines.

2. An image display apparatus according to claim  
1, wherein said signal circuit includes a modulation  
15 circuit for generating a signal having a duration  
equivalent to a high-level period that correspond with  
a signal having a predetermined value; and wherein said  
signal having a duration equivalent to said corrected  
high-level period is a signal that is generated, by  
20 said modulation circuit, in accordance with a signal  
having a value that is corrected based on a value of a  
luminance signal corresponding to a signal to be  
applied to an adjacent line.

3. An image display apparatus according to claim  
1, wherein said signal circuit includes a modulation  
circuit for generating a signal having a duration

equivalent to a high-level period that correspond with a signal having a predetermined value; and wherein said signal having a duration equivalent to said corrected high-level period is a signal that is generated, by  
5 said modulation circuit, in accordance with a signal having a value that is corrected based on the length of a high-level period of a signal to be applied to an adjacent line.

10 4. An image display apparatus according to one of claims 1 to 3, wherein, during a predetermined time period, said signal circuit applies, to said plurality of lines, signals for which the rising times in high-level periods are identical.

15 5. An image display apparatus according to claim 4, wherein, for each of said signals to be applied to said lines, said signal circuit extends the length of said high-level period when the length of said high-level period for a signal to be applied to an adjacent  
20 line is shorter.

25 6. An image display apparatus according to one of claims 1 to 3, wherein, during a predetermined time period, said signal circuit applies, to said plurality of lines, signals for which the falling times in high-level periods are identical.

7. An image display apparatus according to claim 6, wherein, for each of said signals to be applied to said lines, said signal circuit reduces the length of said high-level period when the length of said high-level period for a signal to be applied to an adjacent line is shorter.

8. An image display apparatus comprising:  
a plurality of lines;  
10 a plurality of display devices to which signals are respectively applied by said plurality of lines;  
and  
a signal circuit for generating said signals, each of which has a duration equivalent to a high-level period corrected in accordance with the number of times  
15 the level of a signal, which is to be applied to an adjacent line, is changed during a high-level period for a signal that is to be applied to each of said plurality of lines.

20 9. An image display apparatus according to claim 8, wherein said signal circuit includes a modulation circuit for producing a signal having a duration equivalent to a high-level period that correspond with  
25 a signal having a predetermined value; and wherein said corrected signal, which has a duration equivalent to a high-level period, is produced by said modulation

circuit in accordance with a signal having a value that is corrected based on a value of a luminance signal that corresponds to a signal to be applied to an adjacent line.

5

10. An image display apparatus according to claim 8, wherein said signal circuit includes a modulation circuit for producing a signal having a duration equivalent to a high-level period that correspond with a signal having a predetermined value; and wherein said corrected signal having a duration equivalent to a high-level period is a signal having a duration equivalent to a high-level period that is corrected based on the number of times the level of a signal that is to be applied to said adjacent line is changed.

11. An image display apparatus according to one of claims 8 to 10, wherein, during a predetermined period of time, said signal circuit applies to said plurality of lines, signals for which the rising times in a high-level period are identical.

12. An image display apparatus according to claim 11, wherein, when a signal to be applied to an adjacent line in said high-level period falls, said signal circuit extends the length of said high-level periods for said signals to be applied to said plurality of



lines.

13. An image display apparatus according to one of claims 8 to 10, wherein, during a predetermined period of time, said signal circuit applies, to said plurality of lines, signals for which the falling times in a high-level period are identical.

14. An image display apparatus according to claim 13, wherein, when a signal to be applied to an adjacent line in said high-level period rises, said signal circuit reduces the length of said high-level periods for said signals to be applied to said plurality of lines.

15. An image display apparatus comprising:  
a plurality of lines;

a plurality of display devices to which signals are respectively applied by said plurality of lines;  
and

a signal circuit for generating said signals, each of which, when output to one of said plurality of lines, has a duration that is equivalent to a high-level period that is corrected in order to reduce a change in luminance that occurs in response to a level change for a signal that is to be applied to an adjacent line.

16. An image display apparatus according to claim 15, wherein said signal circuit outputs a signal, which has a duration that is equivalent to a high-level period that is corrected in order to reduce a change in luminance that occurs in response to a level change, for a signal to be applied to an adjacent line, that occurs during said high-level period for each of said signals that are to be applied to each of said plurality of lines.

10

17. An image display apparatus according to one of claims 1 to 3, 5, 7 to 10, 12, and 14 to 16, wherein a second line is provided along which a signal is applied to simultaneously set said plurality of display devices to a semi-driven state.

15

18. An image display apparatus according to claim 17, wherein a plurality of said second lines are provided, and wherein said plurality of display devices correspond respectively to said second lines.

20

19. An image display apparatus according to claim 18, wherein said signal for setting said semi-driven state is a scan signal for sequentially selecting said second lines.

25

20. An image display apparatus according to one

of claims 3, 5, 7 to 10, 12 and 14 to 16, wherein said display devices are composed of electron emission devices, and wherein, in order to form an image, phosphors are irradiated by electron beams that are  
5 emitted by said electron emission devices.

21. An image display apparatus according to claim 4, wherein a second line is provided along which a signal is applied to simultaneously set said plurality  
10 of display devices to a semi-driven state.

22. An image display apparatus according to claim 21, wherein a plurality of said second lines are provided, and wherein said plurality of display devices  
15 correspond respectively to said second lines.

23. An image display apparatus according to claim 22, wherein said signal for setting said semi-driven state is a scan signal for sequentially selecting said  
20 second lines.

24. An image display apparatus according to claim 4, wherein said display devices are composed of electron emission devices, and wherein, in order to  
25 form an image, phosphors are irradiated by electron beams that are emitted by said electron emission devices.

25. An image display apparatus according to claim 21, wherein said display devices are composed of electron emission devices, and wherein, in order to form an image, phosphors are irradiated by electron beams that are emitted by said electron emission devices.

26. An image display apparatus according to claim 22, wherein said display devices are composed of electron emission devices, and wherein, in order to form an image, phosphors are irradiated by electron beams that are emitted by said electron emission devices.

27. An image display apparatus according to claim 23, wherein said display devices are composed of electron emission devices, and wherein, in order to form an image, phosphors are irradiated by electron beams that are emitted by said electron emission devices.

28. An image display apparatus according to claim 6, wherein a second line is provided along which a signal is applied to simultaneously set said plurality of display devices to a semi-driven state.

29. An image display apparatus according to claim

28, wherein a plurality of said second lines are provided, and wherein said plurality of display devices correspond respectively to said second lines.

5           30. An image display apparatus according to claim 29, wherein said signal for setting said semi-driven state is a scan signal for sequentially selecting said second lines.

10           31. An image display apparatus according to claim 6, wherein said display devices are composed of electron emission devices, and wherein, in order to form an image, phosphors are irradiated by electron beams that are emitted by said electron emission  
15           devices.

          32. An image display apparatus according to claim 28, wherein said display devices are composed of electron emission devices, and wherein, in order to  
20           form an image, phosphors are irradiated by electron beams that are emitted by said electron emission devices.

          33. An image display apparatus according to claim  
25           29, wherein said display devices are composed of electron emission devices, and wherein, in order to form an image, phosphors are irradiated by electron

beams that are emitted by said electron emission devices.

5 34. An image display apparatus according to claim 30, wherein said display devices are composed of electron emission devices, and wherein, in order to form an image, phosphors are irradiated by electron beams that are emitted by said electron emission devices.

10

35. An image display apparatus according to claim 11, wherein a second line is provided along which a signal is applied to simultaneously set said plurality of display devices to a semi-driven state.

15

36. An image display apparatus according to claim 35, wherein a plurality of said second lines are provided, and wherein said plurality of display devices correspond respectively to said second lines.

20

37. An image display apparatus according to claim 36, wherein said signal for setting said semi-driven state is a scan signal for sequentially selecting said second lines.

25

38. An image display apparatus according to claim 11, wherein said display devices are composed of

electron emission devices, and wherein, in order to form an image, phosphors are irradiated by electron beams that are emitted by said electron emission devices.

5

39. An image display apparatus according to claim 35, wherein said display devices are composed of electron emission devices, and wherein, in order to form an image, phosphors are irradiated by electron beams that are emitted by said electron emission devices.

10

40. An image display apparatus according to claim 36, wherein said display devices are composed of electron emission devices, and wherein, in order to form an image, phosphors are irradiated by electron beams that are emitted by said electron emission devices.

15

41. An image display apparatus according to claim 37, wherein said display devices are composed of electron emission devices, and wherein, in order to form an image, phosphors are irradiated by electron beams that are emitted by said electron emission devices.

20

25

42. An image display apparatus according to claim

13, wherein a second line is provided along which a signal is applied to simultaneously set said plurality of display devices to a semi-driven state.

5           43. An image display apparatus according to claim 42, wherein a plurality of said second lines are provided, and wherein said plurality of display devices correspond respectively to said second lines.

10           44. An image display apparatus according to claim 43, wherein said signal for setting said semi-driven state is a scan signal for sequentially selecting said second lines.

15           45. An image display apparatus according to claim 13, wherein said display devices are composed of electron emission devices, and wherein, in order to form an image, phosphors are irradiated by electron beams that are emitted by said electron emission  
20           devices.

          46. An image display apparatus according to claim 42, wherein said display devices are composed of electron emission devices, and wherein, in order to  
25           form an image, phosphors are irradiated by electron beams that are emitted by said electron emission devices.



47. An image display apparatus according to claim 43, wherein said display devices are composed of electron emission devices, and wherein, in order to form an image, phosphors are irradiated by electron beams that are emitted by said electron emission devices.

48. An image display apparatus according to claim 44, wherein said display devices are composed of electron emission devices, and wherein, in order to form an image, phosphors are irradiated by electron beams that are emitted by said electron emission devices.

49. An image display method, for displaying an image using a plurality of lines and a plurality of display devices to which signals are respectively applied by said plurality of lines, whereby said display devices are driven by the output, to said plurality of lines, of a signal that has a duration, which is equivalent to a high-level period, that is corrected in accordance with the length of a high-level period for a signal that is to be applied to a line adjacent to each of said plurality of lines.

25

50. An image display method, for displaying an image using a plurality of lines and a plurality of

display devices to which signals are respectively  
applied by said plurality of lines, whereby said  
display devices are driven by the output, to said  
plurality of lines, of a signal having a duration,  
5 which is equivalent to a high-level period, that is  
corrected in accordance with the number of times the  
level of a signal that is to be applied to an adjacent  
line is changed during a high-level period for a signal  
that is to be applied to each of said plurality of  
10 lines.

51. An image display method, for displaying an  
image using a plurality of lines and a plurality of  
display devices to which signals are respectively  
15 applied by said plurality of lines, whereby said  
display devices are driven by the output, to said  
plurality of lines, of a signal that has a duration,  
which is equivalent to a high-level period, that is  
corrected in order to reduce a change in luminance,  
20 which is due to a change in the level of a signal that  
is to be applied to an adjacent line.

ABSTRACT OF THE DISCLOSURE

According to the present invention, the affect of the fluctuation of a signal that is caused by interference between the lines of an image display apparatus can be reduced.

According to the present invention, an image display apparatus comprises a plurality of lines, a plurality of display devices to which signals are respectively transmitted along the lines, and a signal circuit for generating the signals. The signal circuit outputs a signal having a duration, which is equivalent to a high-level period, that has been corrected in accordance with the length of a high-level period for a signal that is to be transmitted to an adjacent line of each line or in accordance with the number of times the level of a signal that is to be transmitted to an adjacent line is changed during the high-level period, or in order to reduce a change in luminance due to a level change for a signal that is to be transmitted to an adjacent line. Preferably, to correct a luminance signal that is input to terminal d, a crosstalk correction unit employs for its own line luminance signals for adjacent lines.

FIG. 1

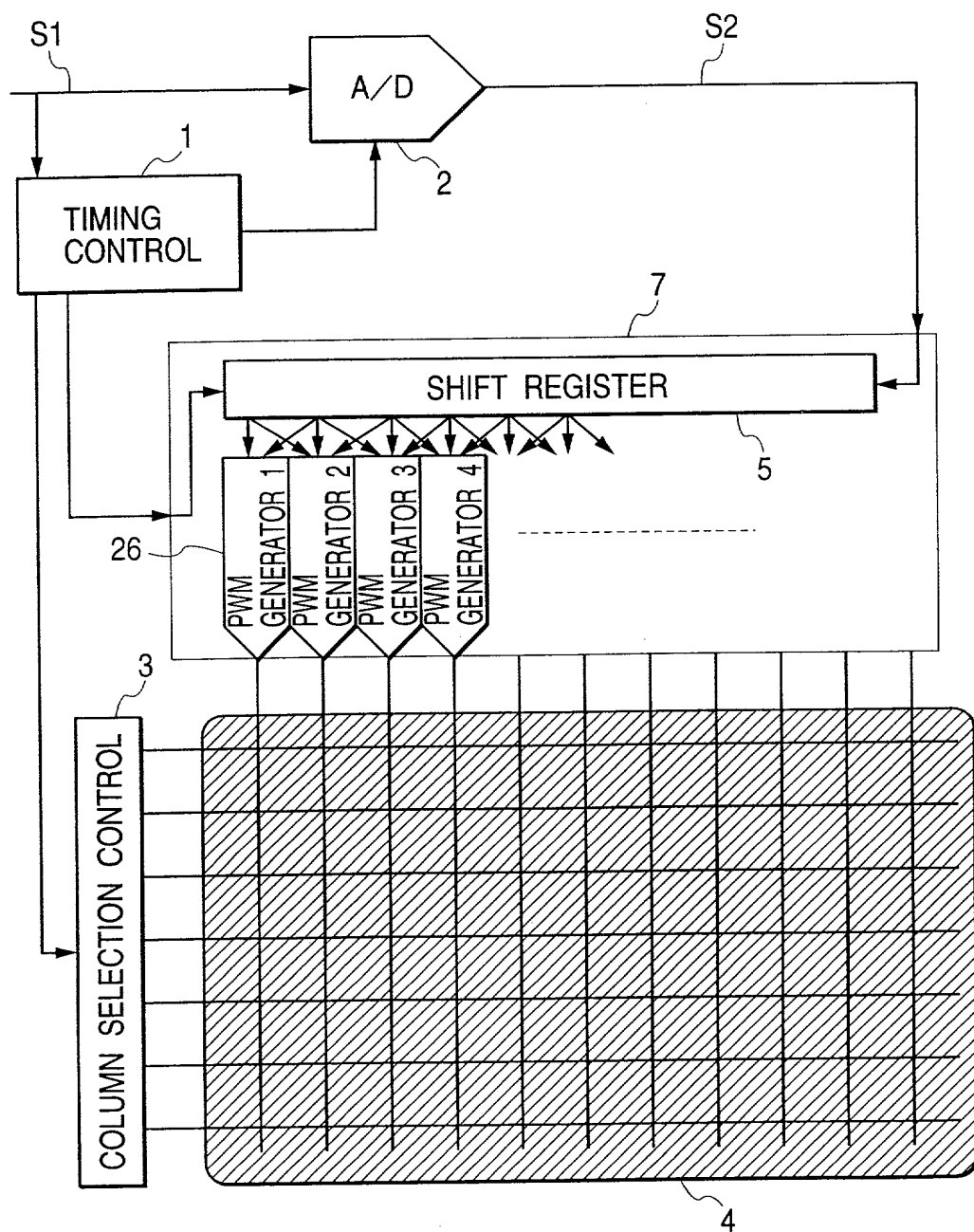


FIG. 2

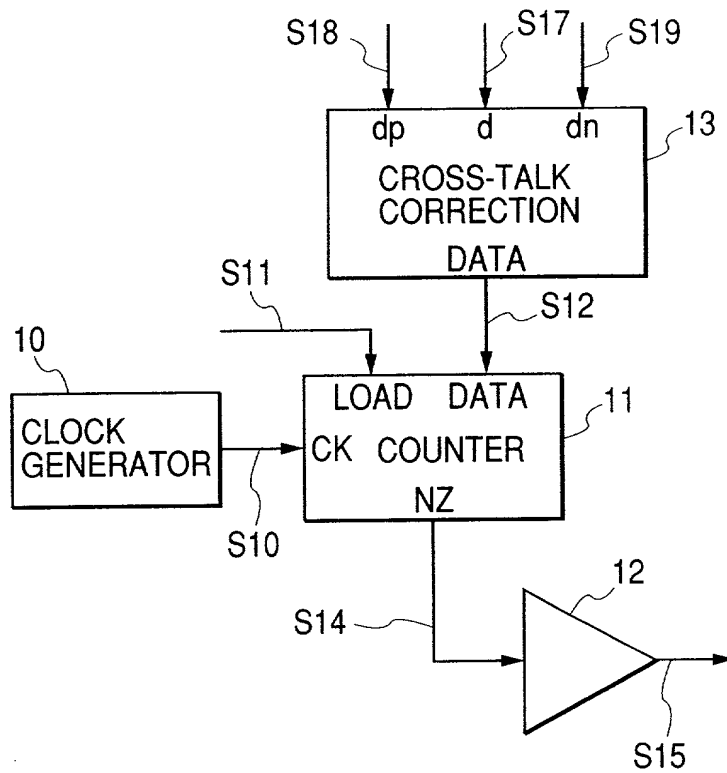


FIG. 3

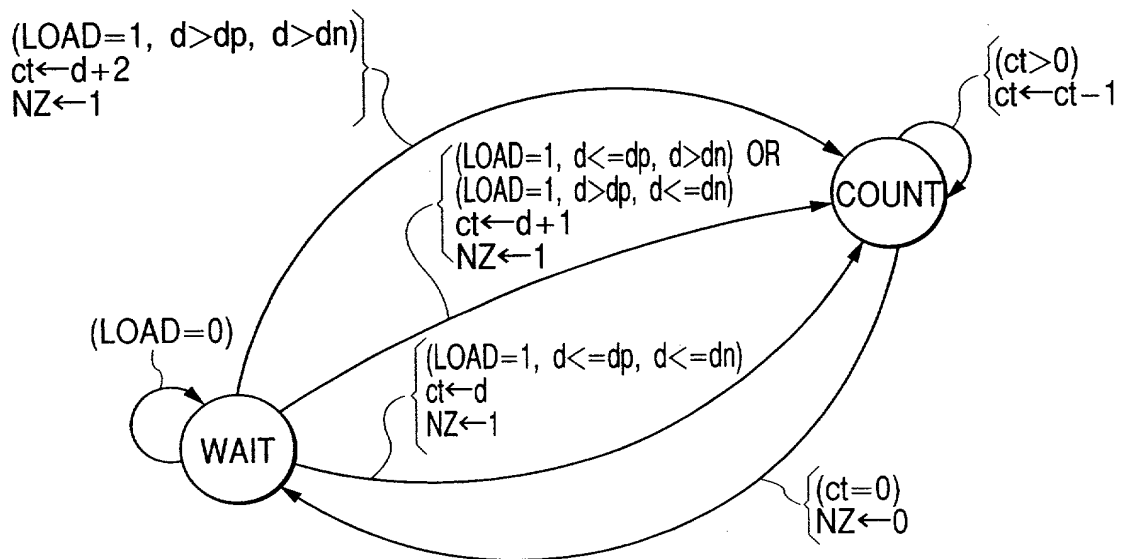


FIG. 4

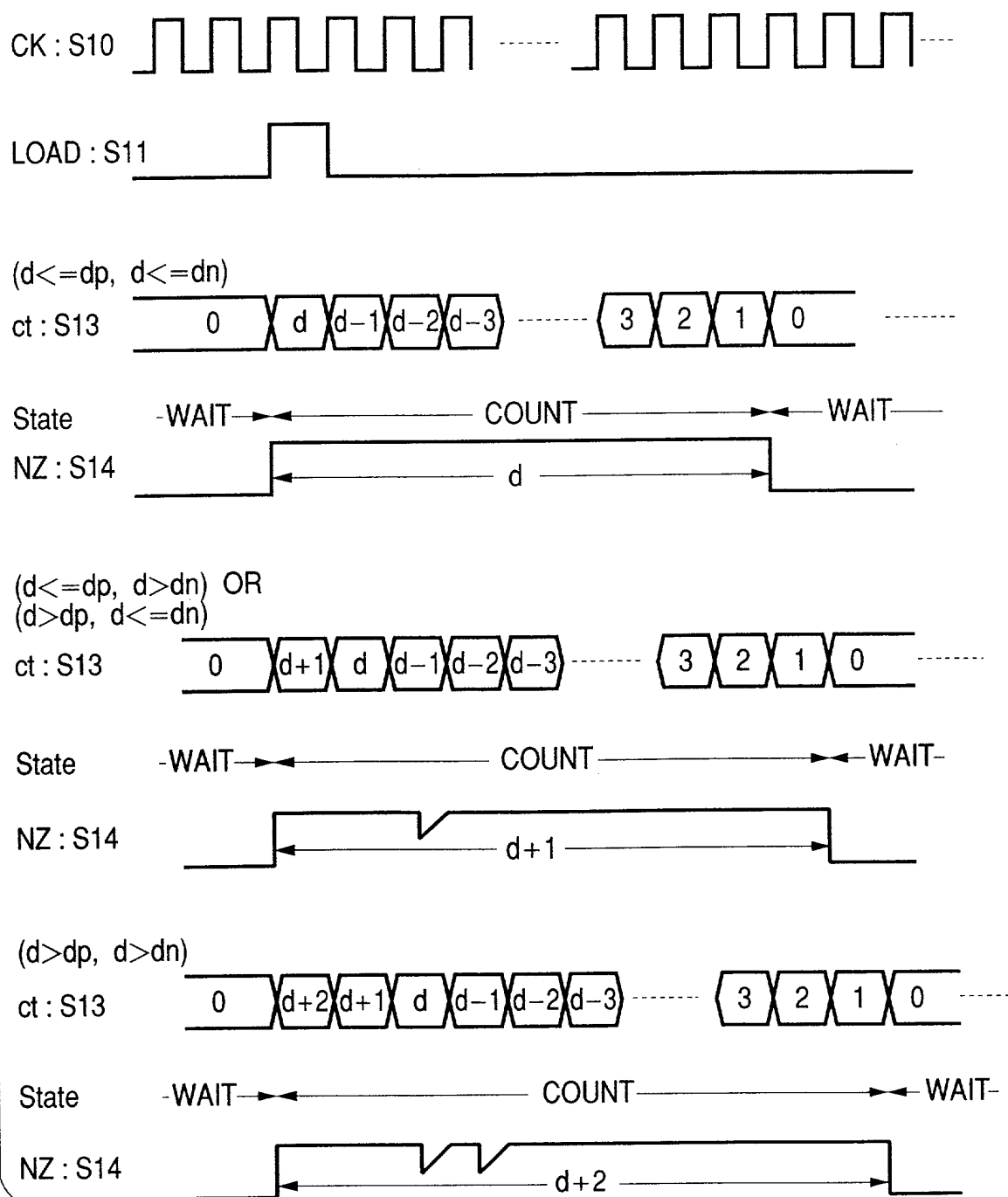
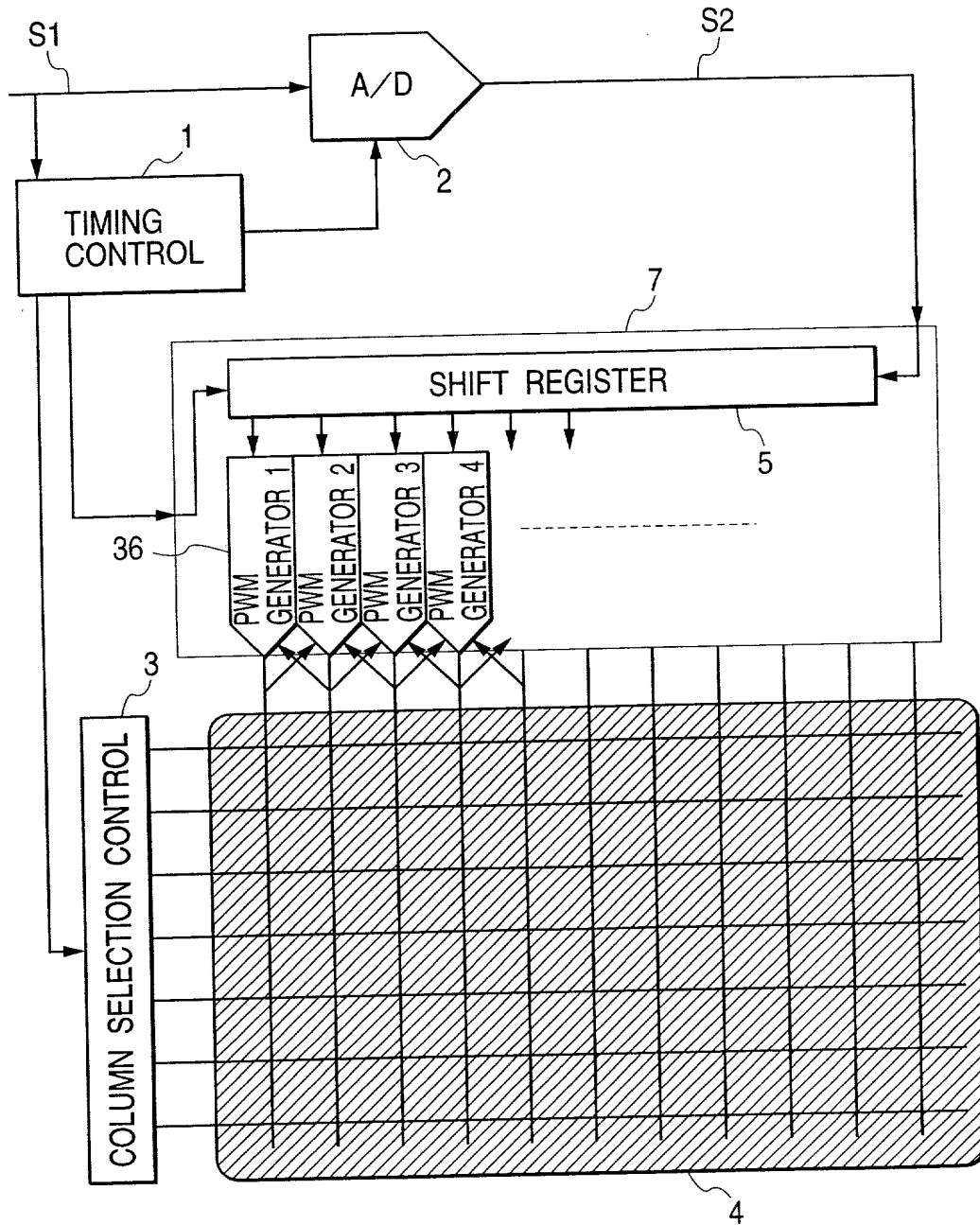


FIG. 5



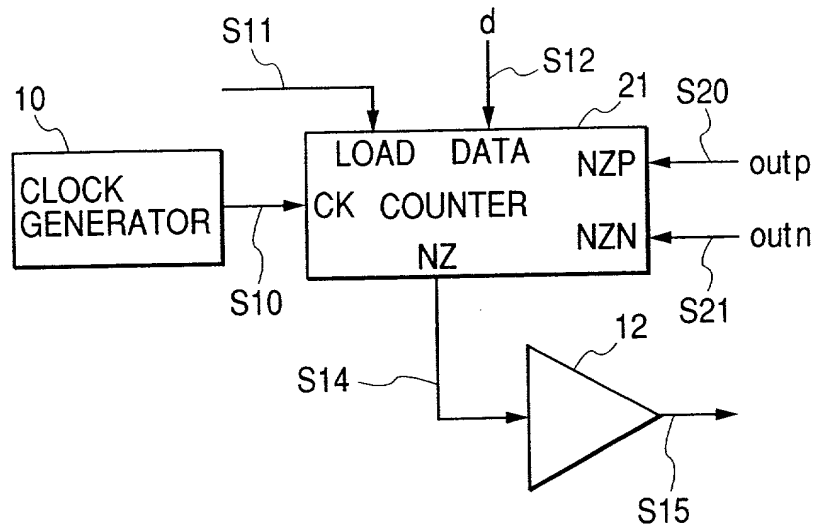
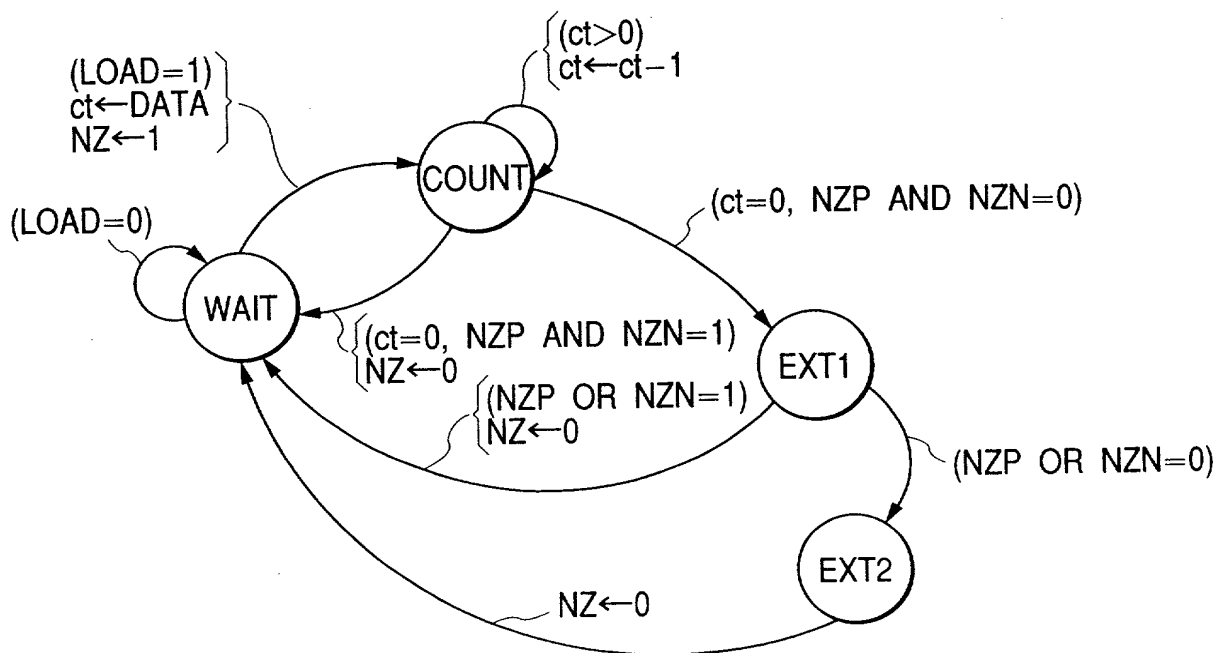
**FIG. 6****FIG. 7**



FIG. 8

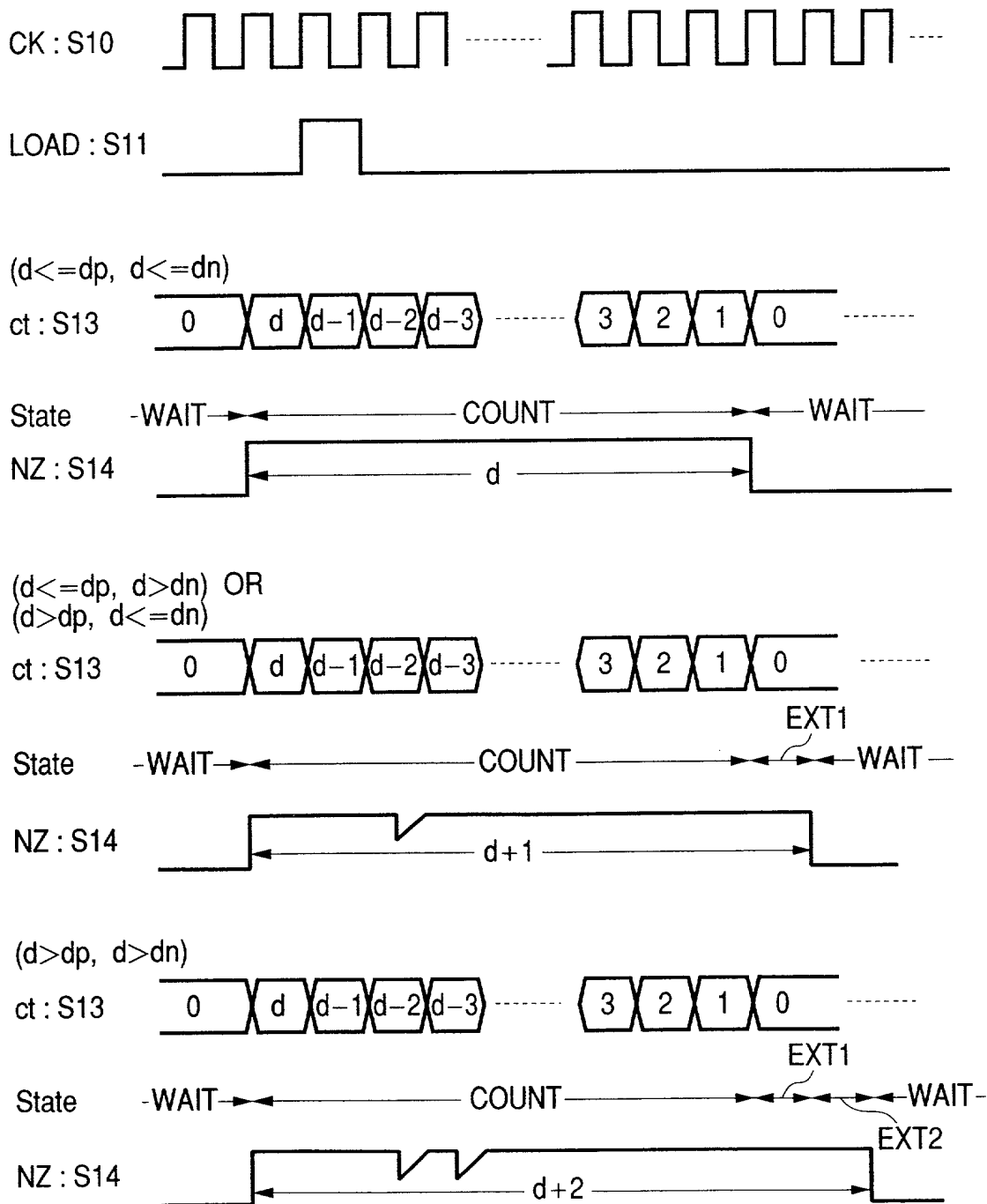


FIG. 9

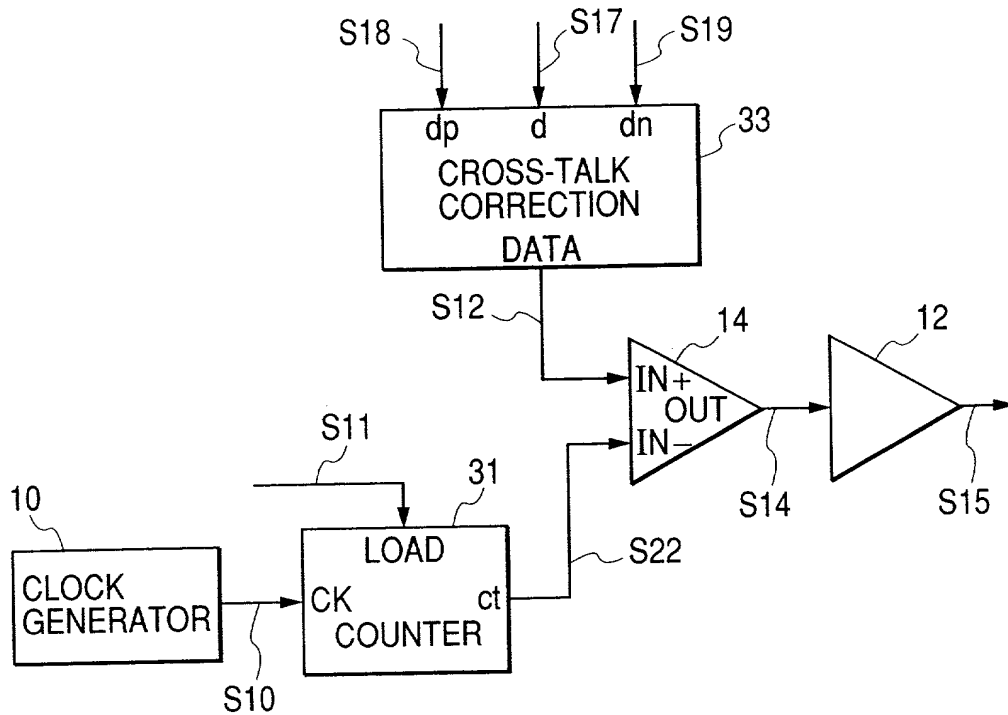


FIG. 10

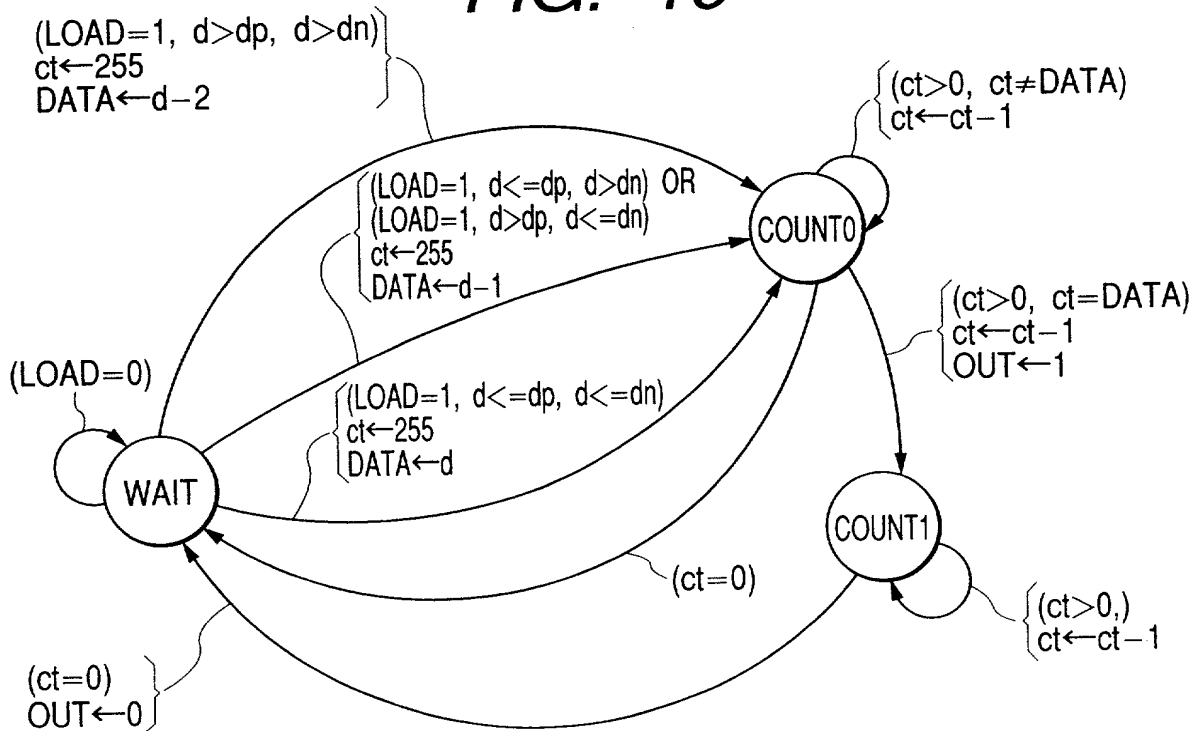
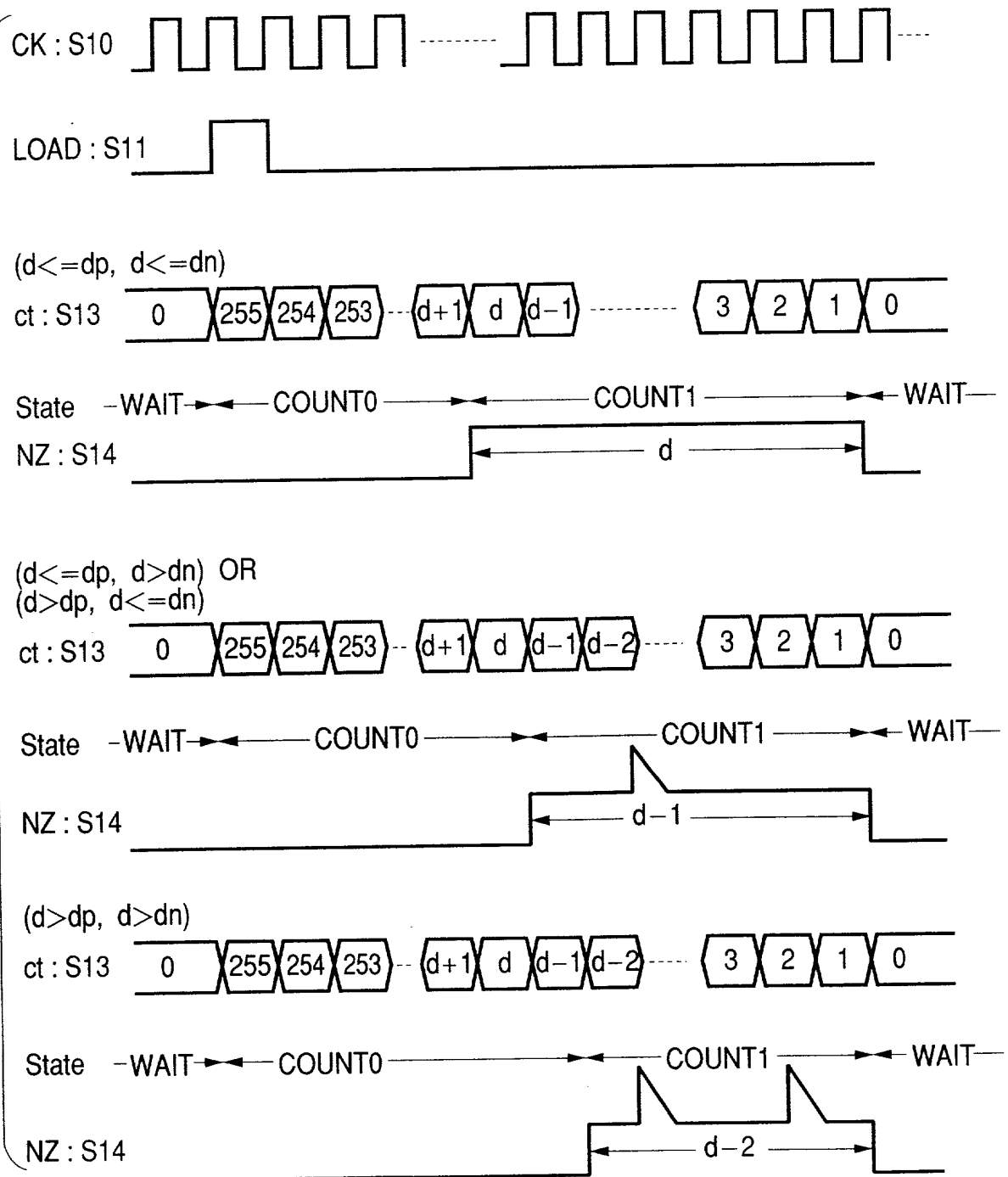


FIG. 11



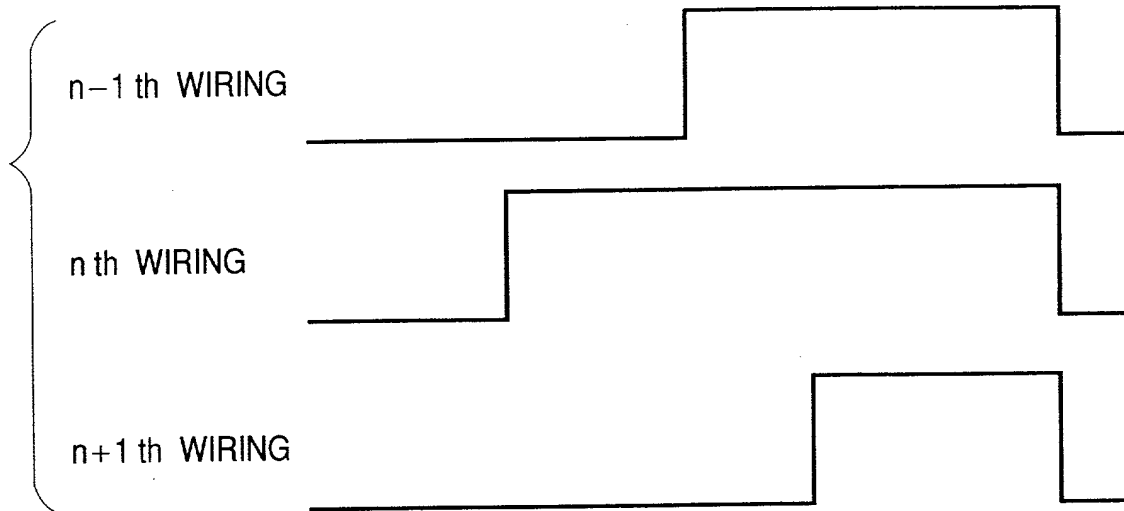
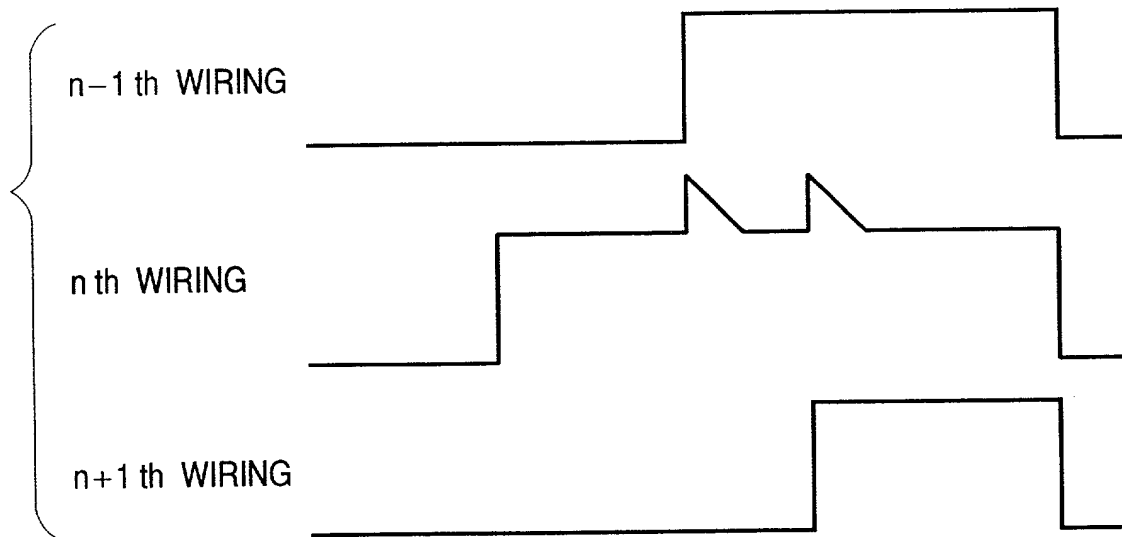
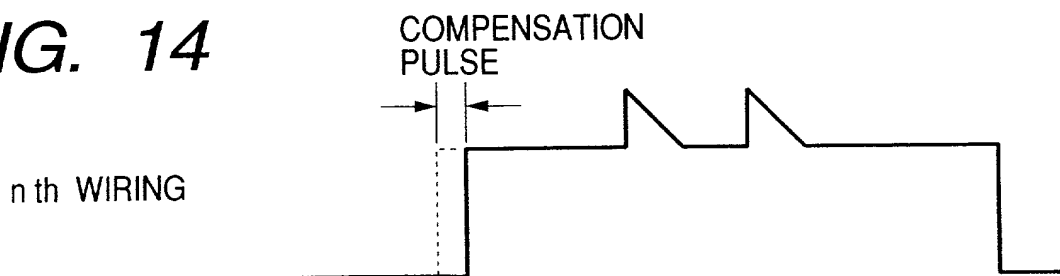
**FIG. 12****FIG. 13****FIG. 14**

FIG. 15

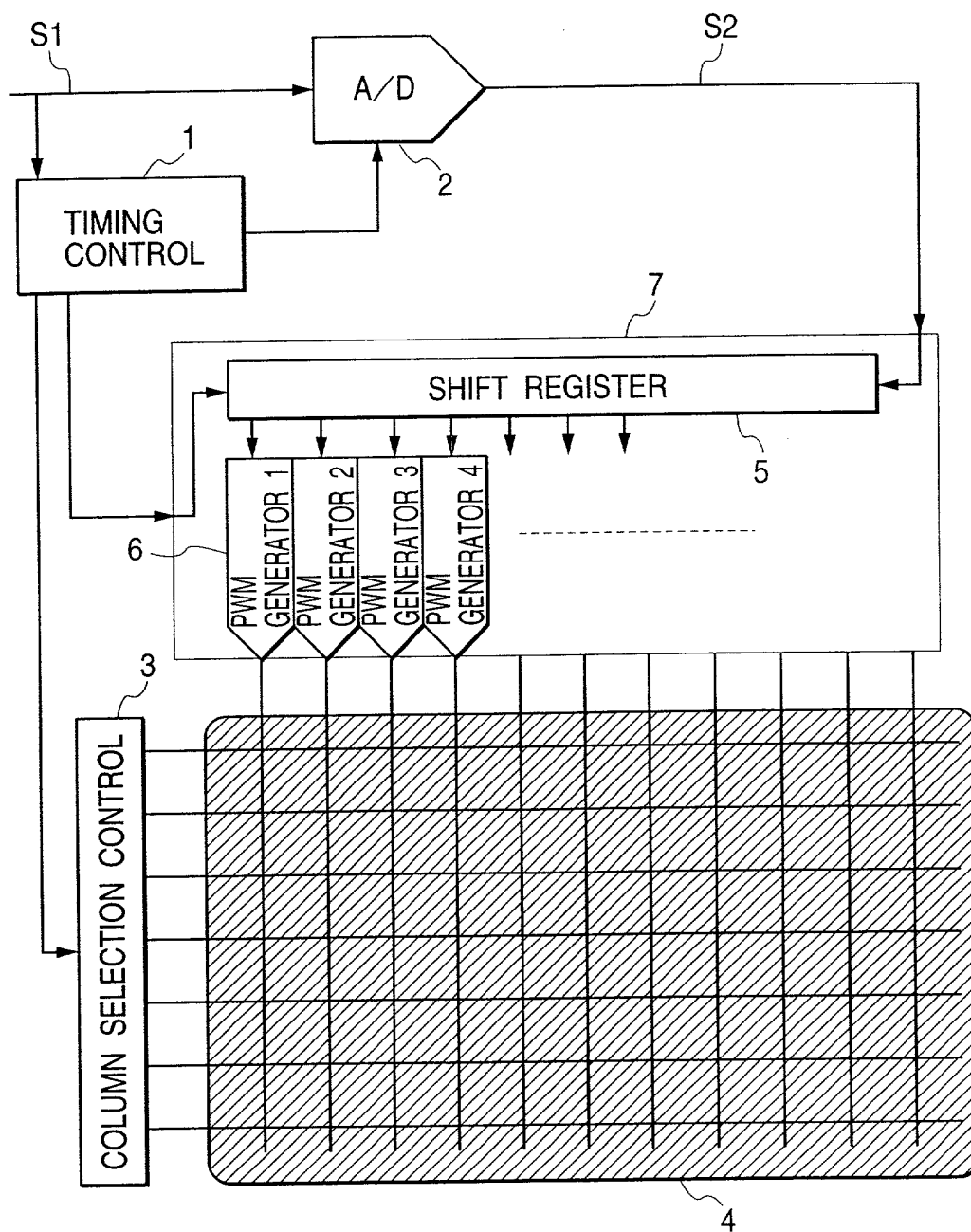
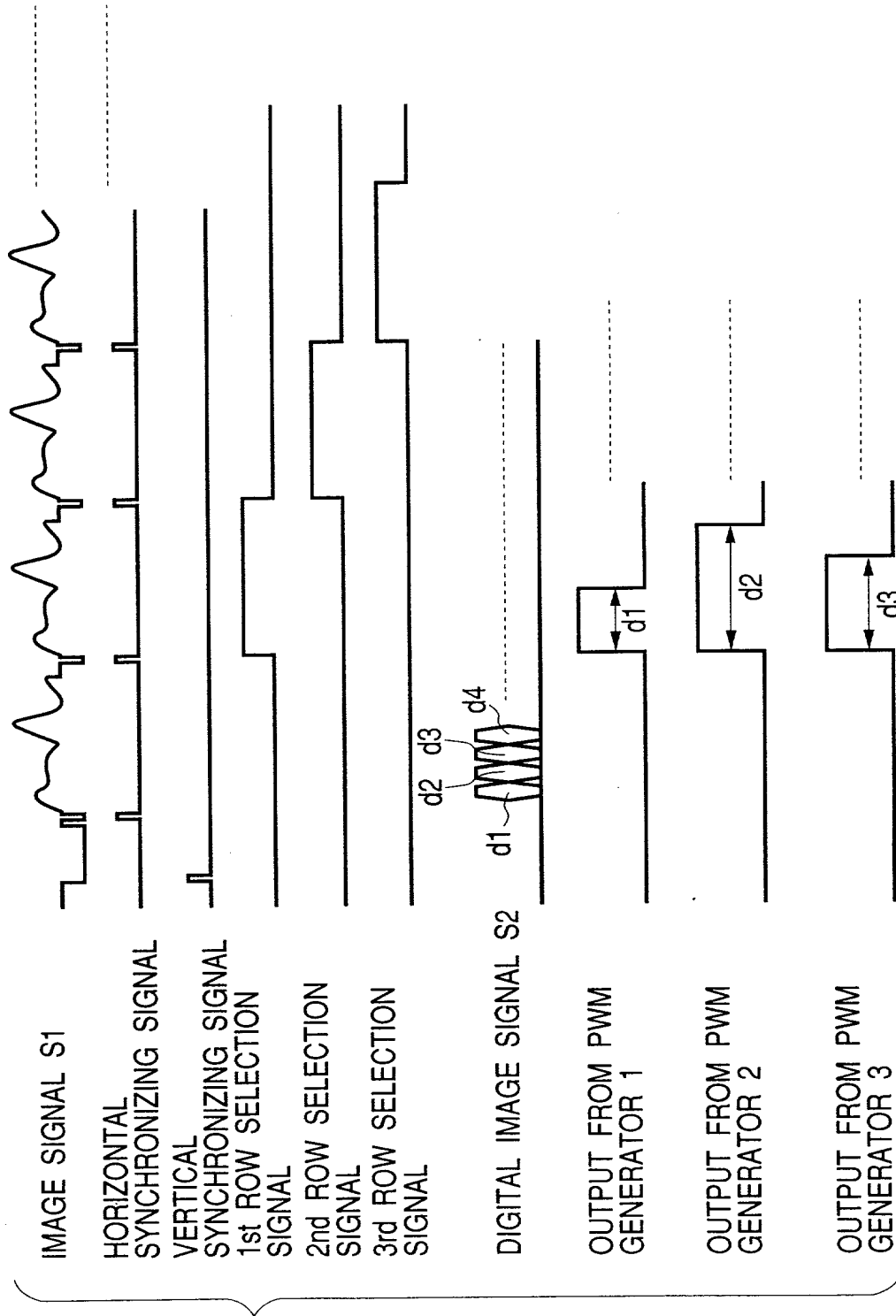
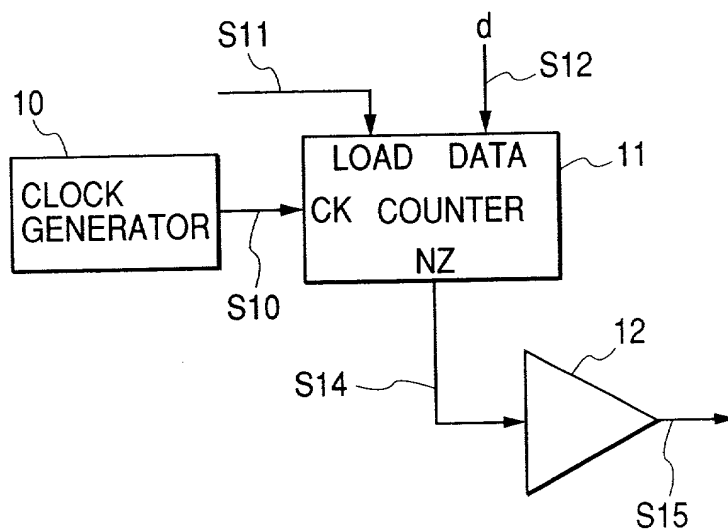
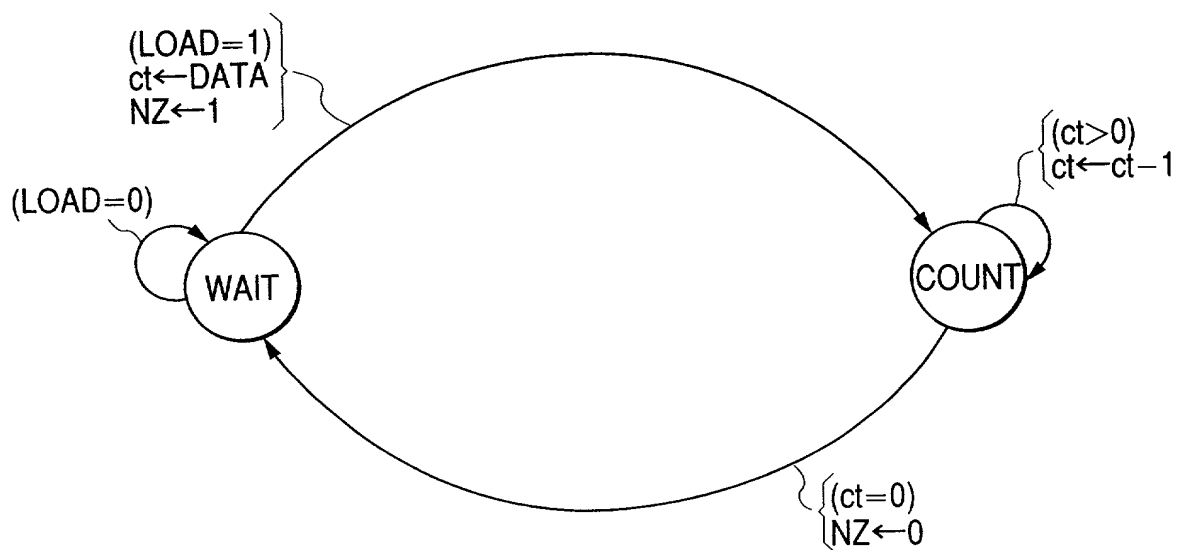
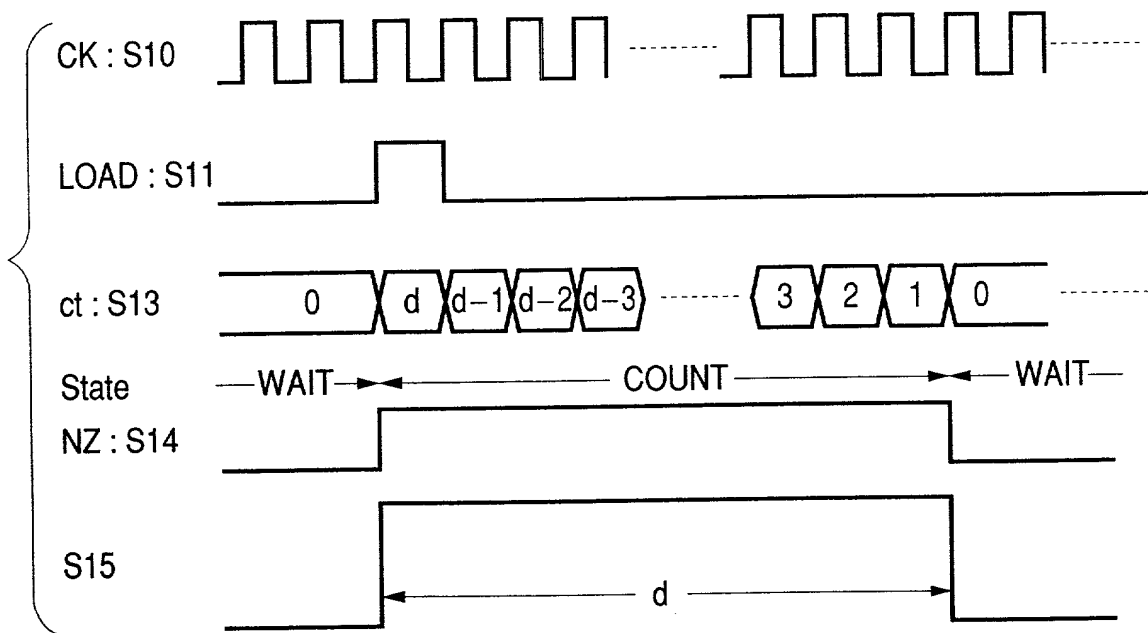


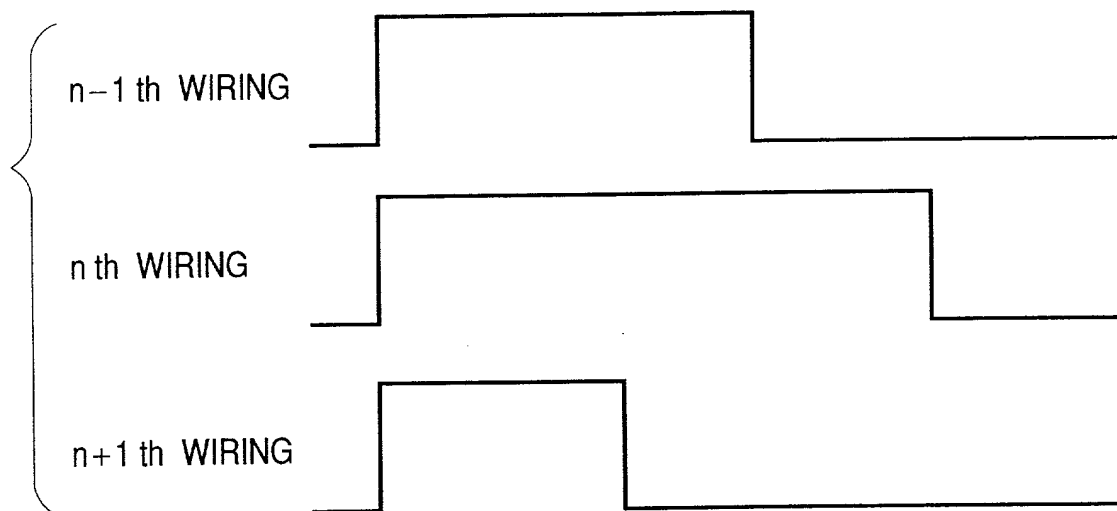
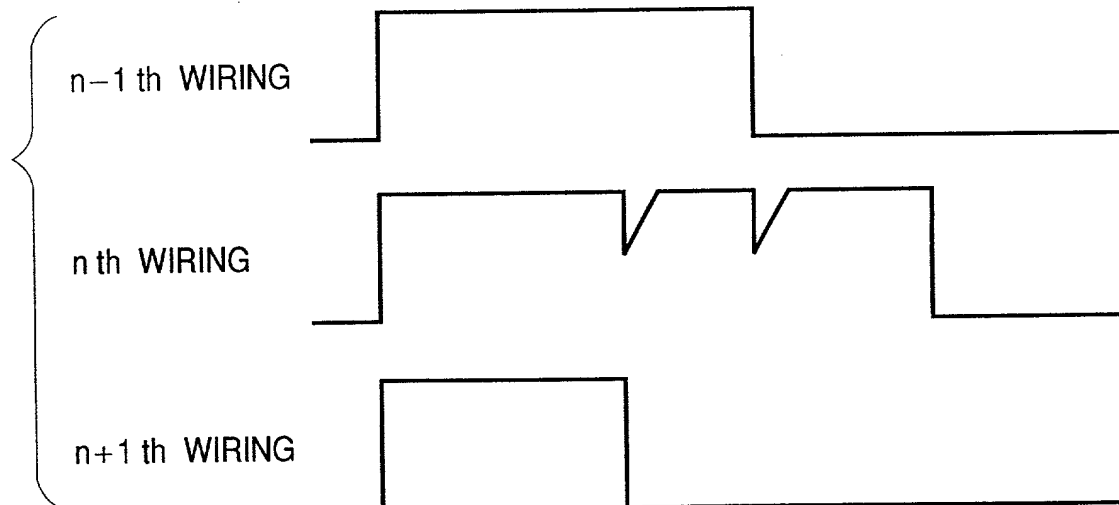
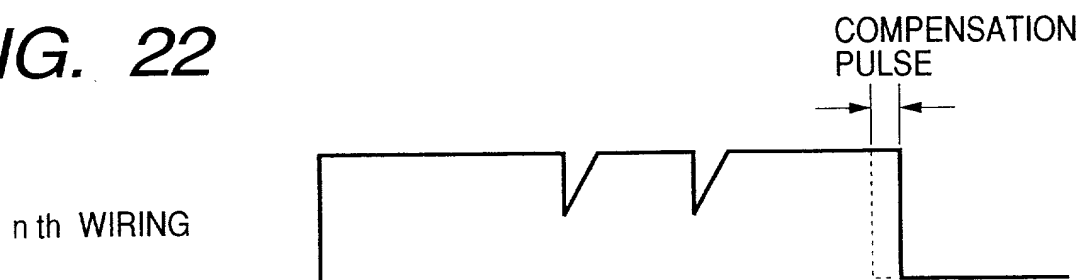
FIG. 16



**FIG. 17****FIG. 18**

*FIG. 19*



**FIG. 20****FIG. 21****FIG. 22**

**COMBINED DECLARATION AND POWER OF ATTORNEY  
FOR PATENT APPLICATION**  
(Page 1)

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled IMAGE  
DISPLAY APPARATUS AND METHOD

the specification of which ☒ is attached hereto ☐ was filed on \_\_\_\_\_ as United States  
Application No. or PCT International Application No. \_\_\_\_\_  
and was amended on \_\_\_\_\_ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR §1.56.

I hereby claim foreign priority benefits under 35 U.S.C. §119(a)-(d) or §365(b), of any foreign application(s) for patent or inventor's certificate, or § 365(a) of any PCT international application which designates at least one country other than the United States, listed below and have also identified below any foreign application for patent or inventor's certificate, or PCT international application having a filing date before that of the application on which priority is claimed:

<u>Country</u>	<u>Application No.</u>	<u>Filed (Day/Mo./Yr.)</u>	<u>(Yes/No)</u> <u>Priority Claimed</u>
Japan	11-045531	February 23, 1999	Yes
Japan	11-366624	December 24, 1999	Yes

I hereby claim the benefit under 35 U.S.C. § 120 of any United States application(s), or § 365(c) of any PCT international application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT international application in the manner provided by the first paragraph of 35 U.S.C. § 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 C.F.R. § 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

<u>Application No.</u>	<u>Filed (Day/Mo./Yr.)</u>	<u>Status (Patented, Pending, Abandoned)</u>
------------------------	----------------------------	--

I hereby appoint the practitioners associated with the firm and Customer Number provided below to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith, and direct that all correspondence be addressed to the address associated with that Customer Number:

**FITZPATRICK, CELLA, HARPER & SCINTO**  
**Customer Number: 05514**

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full Name of Sole or First Inventor MUNEKI ANDO

Inventor's signature \_\_\_\_\_

Date \_\_\_\_\_ Citizen/Subject of Japan

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